INFLATABLE STRUCTURE

Cross Reference to Related Application

[00001] This application is a continuation-in-part of co-pending International Application No. PCT/ZA01/00175, filed on November 14, 2001 and claims priority of South African Application No. 2000/6289, filed November 14, 2000.

Field of the Invention

[00002] This invention relates to an inflatable structure.

Description of the Prior Art

[00003] The applicant is the patentee in respect of South African Patent No. 97/ 5569 - Inflatable tent frame - which describes a frame comprising at least three tubular legs each constituting a separately sealed chamber that is capable of being inflated with a fluid such as air or gas to constitute a frame structure for a tent or canopy.

[00004] Conventionally, inflatable structures such as inflatable boats, inflatable life rafts and the like are manufactured from airtight fabrics. These fabrics conventionally consist of a polyvinyl chloride (PVC) fabric reinforced with woven polyester. The fabric is cut and welded, either with the use of heat welding or with adhesives, to obtain the desired shapes.

[00005] However, tubes that are relatively long and narrow tend to distort, particularly if they are unsupported. Thus for example to endeavour to deal with this problem large numbers of inflatable tubes are used in an arrangement as shown in French Patent No. 2697045 (A.S. Semmel). This is complex and expensive.

[00006] This kind of problem normally does not arise with inflatable water craft since these craft utilise relatively short, large diameter tubes and normally include rigid or semi-rigid structures to which the tubes are attached.

[00007] In the known inflatable tent technology it is very difficult to construct a frame that is fully free standing, unsupported by anchors and anchor ropes. Stability is normally achieved by utilising relatively large diameter tubes combined with an anchoring system, making the tent relatively heavy and expensive, limiting the application potential to relative small-specialised market sectors. The arrangement of tubes in tetrahedron formation is disclosed in British Patent No. 2090622. Here the ends of all three tubes engage the ground. There is no learning that these tubes can be connected together.

[00008] Frame structures as typically utilised in a tent or canopy, utilise structural intersections that are typically too complex and difficult to manufacture with the current state of art in inflatable tube manufacturing.

[00009] In conventional tent construction where the frame is constructed out of solid structural elements such as metal tubing or spring steel rods, a fair amount of labour and knowledge and time is needed to construct the tent. These tents, even in their simplest form still comprise different parts that need assembly. In US Patent 3,502,091 (Corbin) there is shown a tent supporting frame comprising a ridge struts which are hinged together and to side struts. In order for the frame to take up a support position, a complicated hub with an extendable rod therethrough is provided and cable system including lock means is provided to draw the ridge struts into the desired position.

[000010] In US Patent No. 2,938,526 (Harrison III, et al) there is described an inflatable shelter including an arrangement of tubes some of which are arranged in tetrahedron formation

wherein a cap portion is provided to which twelve inflatable struts are connected. Although this may seem to be theoretically possible, it is doubted whether this can be provided in practice. The cap portion is too complicated to be practically possible to manufacture. Furthermore, with the arrangement in this specification, ropes are required to connect the ends of the formations to permit the structure to be erected. In addition spoke-like tubes are provided between the formation leading to the cap portion. This will mean that webbing members on either side of each spoke-like tube will be inclined to one another making for a complex internal shape.

[000011] It is an object of this invention to provide tubular structural elements that address these deficiencies and to provide structures that utilise such structural elements.

Summary of the Invention

[000012] According to this invention there is provided a structure comprising at least three structural units each consisting of three inflatable legs, two of which constitute support legs and the third constituting an apical leg, each leg having a free end and an inner end, the inner ends of the three legs being joined at a centrepoint, the legs being arranged to define a tetrahedron with the three legs lying on three adjacent edges of the tetrahedron and with adjacent pairs of legs lying in planes of three sides of the tetrahedron, and the free ends of the legs define the fourth side of the tetrahedron; wherein the free ends of the units are closed and wherein the units are arranged each with one leg joined to corresponding legs of the other units at a joint position.

[000013] The three legs of each unit are preferably of the same length although two of the legs are of the same length and the third leg is of a different length. Preferably each leg is

straight. Each leg preferably comprises a plastic reinforced by a woven fabric. The warp of the fabric is conveniently aligned with the tube axis.

[000014] A connector unit is conveniently provided at the free end of at least one of the legs whereby it may be connected to a similar leg of another structural unit.

[000015] Being polyhedral, the structural element of the invention will yield, in combination with similar structural elements, a variety of geodesic structures. In such structures, the apical legs of the structural elements may be secured to the apical legs of adjacent, similar structural elements. In the same way the support legs of the structural elements may be secured to the support legs of adjacent, similar structural elements.

[000016] The apical leg of each structural element may be provided with mating connector formations to permit easy connection and disconnection to the apical legs of adjacent structural elements. In the same way the support legs of each structural element may be provided with mating connector formations to permit easy connection and disconnection to the support legs of adjacent structural elements.

[000017] In the preferred form of the invention, the connector constitutes the mating track and slider formations that can be inter engaged with one another to connect the structural elements together.

[000018] The tube ends of each structural element is geometrically shaped along the natural complimentary lines along the intersecting surfaces of the

adjacent structural element. The connectors are fixed along their relative axial angles.

[000019] Connecting adjacent structural elements in this manner is simple yet it results in a very strong and supportive joint, utilising the inherent strength of the inflatable tube.

[000020] Structural elements connected together into a composite structure in this way form a very stable inflated structure.

Brief description of the drawings

[000021] Figure 1 is a diagrammatic isometric view of a tetrahedral structural element according to this invention.

[000022] Figure 2 is a diagrammatic plan view of a simple inflatable structure made up of four of the structural elements of Figure 1.

[000023] Figure 3 is a diagrammatic end elevation of the structure of Figure 2.

[000024] Figure 4 is a diagrammatic plan view on the point of connection of the structural elements in the structure of Figures 2 and 3.

[000025] Figure 5 is a diagrammatic sectional side elevation illustrating a novel lighting arrangement for structures according to the invention.

[000026] Figures 6,7 and 8 are diagrammatic plan view, end elevation and side elevation respectively of a structure that combines the structural element of Figure 1 with a number of similar and dissimilar units to provide a more complex geodesic dome structure than that illustrated in Figures 2 and 3.

Detailed Description of embodiments of the invention

[000027] The inflatable structure of the invention is more of a construction system than a simple structure. The system relies on the use of an inflatable polyhedral structural element as its basic unit of construction. By combining such a structural element with similar structural elements or with similarly polyhedral structural elements, a large variety of structures can be created as will be illustrated below.

[000028] The structural element 10 illustrated in Figure 1 has an essentially tetrahedral shape. A tetrahedron, being a polyhedron with four triangular sides, the structural element is made of three inflatable relatively narrow tubes 10.1, 10.2, 10.3, each lying on an edge of the tetrahedron. Three of the triangular sides of the tetrahedron are constituted by the triangular planes included between the three legs and the fourth triangular side is constituted by the plane defined by the free ends of the legs.

[000029] Seen differently, the structural element constitutes an inverted Y shaped support element.

[000030] The legs 10.1 and 10.2 lie on the inverted arms of the Y and constitute support legs. The remaining leg 10.3 defines the stem of the Y, which is angled relatively to the legs 10.1, 10.2 to define a support beam in structures to be erected with the use of the structural element 10.

[000031] The tubes making up the legs 10.1, 10.2, 10.3 of the structural support element are made from airtight PVC fabric reinforced with woven polyester.

[000032] The woven polyester reinforcing fabric is arranged with the warp thereof aligned longitudinally with the principal axis of each of the tubular legs 10.1, 10.2, and 10.3. This gives the tubes a high resistance to bending.

[000033] If it is desired to permit curvature of the tubes to provide a more dome shaped tetrahedron, the polyester reinforcing fabric may be arranged on the bias (with the warp at an angle to the tube axis) to a greater or lesser degree, depending on the curvature that will be permitted.

[000034] The airtight fabric is double welded along the length of each tube. In practice, the fabric is welded along axially extending seams with a separate strip of fabric welded internally along each of the seams to provide enhanced sealing.

[000035] The tubes making up the legs 10.1, 10.2 and 10.3 are interconnected at their inner ends 10a across a joint 12 through which the pressurising fluid can flow freely during inflation and deflation of the structural element 10. The closed end of each legs 10.1, 10.2 and 10.3 is geometrically shaped along the natural complimentary lines along the intersecting surfaces of the adjacent structural element.

[000036] The structural element 10 is inflated and deflated by means of an inflation valve (illustrated diagrammatically at 14). The inflatable tubes are airtight and once it is filled with compressed gas to the desired pressure and sealed off, will maintain its rigidity and support strength without any further addition of compressed air.

[000037] The most convenient pressurising fluid would be compressed air obtained from a blower or compressor, or from a pressurised gas canister, but alternative pressurising fluids such as motor vehicle exhaust gas could also be used, provided the appropriate inflation fittings are used.

[000038] The structural element 10 of the invention can be combined into relatively complex structures that, because of the tetrahedral shape of the unit 10, will have the characteristics of geodesic domes.

[000039] The simple structure 100 illustrated in Figures 2 and 3 provides an example of the structure building capabilities of the basic structural element 10.

[000040] In the structure 100, four of the units 10 are interconnected to form a four-sided structural frame.

[000041] The apical legs 10.3 of the units 10 are connected to one another at the apex 102 of the structure 100 by means of connectors that will be described below. At the connection there are preferably valves leading into support legs 10.2 and 10.2 near their lower closed ends. The valves of adjacent legs are connected by means of short hoses during inflation so that the entire structure can be inflated from a single inflation valve 14.

[000042] The support legs 10.1 and 10.2 of the structural elements 10 extend down to the ground and are connected to one another by means of connectors that will be described below.

[000043] The structure 100 may now be clad with a fabric cover (not shown).

[000044] Once the structure 100 is clad with a fabric cover and fastened to a groundsheet, it is completely free standing and needs no pegs or anchor ropes to keep it stable. Very little experience or knowledge is now required to pitch the tent. The energy that pitches the tent is supplied by the compressed gas and the whole process is done in a fraction of the normal time. There is also no assembly needed to pitch the tent. The unit only needs to be unfolded and inflated to pitch the tent. The same applies when putting the tent down. The valves in the tubes are opened to let the compressed gas out and the whole structure collapses. It is then folded as a unit in the normal way. There is thus no poles or other structural elements to account for.

[000045] The structure 100 provides a high degree of wind resistance but, if required, the structure can be pegged to the ground.

[000046] It will be seen that the structure 100 is erected using four separate structural elements 10 that are connected to one another.

[000047] Figure 4 illustrates two of the metal connectors 15 that are used to interconnect the structural element ends 10.4 of the structural elements 10 (the free ends of the legs 10.1, 10.2 and 10.3 of the structural elements 10). The ends 10.4 of the structural elements 10 are shaped complementary to permit interconnection of the structural elements along the axial angle of the completed structure. Each such leg end 10.4 is finished off with a flat end weld 13 that is double welded and inserted between the flat strips of metal making up the connectors 15.

[000048] Each structural element 10 is provided, at its leg ends 10.4 with a connector 15 that comprises a slider 16 and track formation 18, the slider 16 being adapted to slide into the track 18 of an adjacent connector 15. The slider and track formations 16, 18 are dimensioned to provide a secure friction fit once interconnected. The connectors are fixed along their relative axial angles at the vertex of the polyhedron.

[000049] The utilisation of the connector 15 on each tube end has the advantage that two or more tube ends can be interconnected in a very strong and stable bond alleviating the need for a complex welded joint.

[000050] The entire connector 15 is riveted together with blind rivets. This has the advantage that the connector formations 16, 18 can be removed to permit reopening of the tube ends and the servicing of the tubes.

[000051] In certain situations it might be appropriate to insert a gasket within the sealing arrangement constituted by the connector 15 and the welded end of the tube in order to enhance the sealing effect.

[000052] The structure 100 illustrated in Figures 2 and 3 are a relatively simple structure that utilises only the basic structural element 10 illustrated in Figure 1. However, the basic

structural unit 10 can be used in conjunction with similar yet slightly more complex structural elements to provide more complex structures as is illustrated in Figures 6, 7 and 8.

[000053] The structure 200 shown in these drawings utilises three of the basic structural elements 10 at each of its short ends.

[000054] The apex and long sides of the structure 200 are defined by a pair of opposed structural elements 204, each of which incorporates a pair of support legs 204.1 and a pair of apical legs 204.2 that extend upwardly towards an apical beam 206 that defines the apex of the structure 200. The apical legs 10.3 of the elements 10 at each end of the structure 200 are connected to the ends of the beam 206 by means as described above.

[000055] It will be noted that polyhedral, the structural element 10 will yield, in combination with similar structural elements, a variety of geodesic structures. In such structures, the apical legs of the structural elements may be secured to the apical legs of adjacent, similar structural elements. In the same way the support legs of the structural elements may be secured to the support legs of adjacent, similar structural elements. If desired the basic structural elements 10 may be flanked by a slightly modified structural element, each of which differs from the basic structural element 10 only in the fact that it has an asymmetrical tetrahedral shape.

[000056] The structures of the invention, being inflatable, lend themselves to novel uses. For instance, the structure could be internally lit using light fittings 20 fitted to the insides of the tubes making up the structural elements. In this kind of an application, the fabric of the tubes and the structure as a whole will be chosen for translucency to enhance the lighting effect.

[000057] In addition, the structures need not be confined to land. Being inflatable, the structures will float on water to provide a novel staging facility for events and advertising.

[000058] What has been described above are preferred aspects of the present invention. It is of course not possible to describe every conceivable combination of components or methodologies for purposes of describing the present invention, but one of ordinary skill in the art will recognize that many further combinations and permutations of the present invention are possible. Accordingly, the present invention is intended to embrace all such alterations, combinations, modifications, and variations that fall within the spirit and scope of the appended claims.